Title: Neutral data computer control system for a machine tool for producing workpieces having a helicoidal generated surface with data carriers, data carrier signals, a computer system, a computer program and computer program products, and also an associated machine tool

Patent claims

1. Multiaxis machine tool (2) for producing workpieces having a helicoidal generated surface, which has

   a workpiece holder for receiving a workpiece,

   a tool,

   activatable mechanical axes for machining the workpiece or for positioning the workpiece and the tool in relation to each other, and also

   an open-loop and/or closed-loop control device for activating axes,

   characterized in that

   there is provided at least one virtual axis, which can be parameterized as a guiding axis for other axes and then serves only for the synchronization of these other axes.

2. Multiaxis machine tool (2) according to Claim 1, characterized in that at least five activatable mechanical axes are provided for the positioning of the workpiece and the tool in relation to each other.

3. Multiaxis machine tool (2) according to Claim 2, characterized in that a grinding wheel is provided as the tool and, as mechanical axes, at least one

positionable radial infeed axis (χ) is provided for the grinding wheel,

a grinding slide (ζ) which can be positioned horizontally and orthogonally in relation to the radial infeed axis is provided for the positioning of the grinding wheel in the direction of displacement of the grinding slide,

a positionable rotating axis (β) of a clamping head is provided for the rotation of the workpiece in the workpiece holder,

a positionable pivoting axis (τ) is provided for the pivoting of the workpiece and the grinding wheel with respect to each other by means of a rotation of the grinding wheel axis or its parallel projection in the vertical plane (B),

and a rotating axis (ω) is provided for the driving of the grinding wheel.

4. Multiaxis machine tool (2) according to Claim 3, characterized in that a positionable displacing axis (δ) for the monitoring of a displacing position of the grinding wheel along the grinding wheel axis is also provided as a mechanical axis.

5. Multiaxis machine tool (2) as claimed in claim 3 or 4, characterized in that a pivoting axis (σ) for the pivoting of the workpiece and the grinding wheel with respect to each other by means of a rotation of the grinding wheel axis or its parallel

projection in the horizontal plane (A) is also provided as a mechanical axis.

6. Multiaxis machine tool (2) according to one of Claims 3 to 5, characterized in that a displacing axis (η) for the vertical displacement of the workpiece and the grinding wheel with respect to each other is also provided as a mechanical axis.

7. Multiaxis machine tool (2) according to one of Claims 3 to 6, characterized in that a pivoting axis (γ) for the pivoting of the workpiece and the grinding wheel with respect to each other by means of a rotation of the workpiece axis or its parallel projection in the horizontal plane (A) is also provided as a mechanical axis.

8. Multiaxis machine tool (2) according to one of Claims 1 to 7, characterized in that the virtual axis is formed by the open-loop and/or closed-loop control device by means of a freely selectable function or relation.

9. Multiaxis machine tool (2) according to Claim 8, characterized in that the virtual axis is formed by the open-loop and/or closed-loop control device by means of a freely selectable function or relation dependent on time.

10. Multiaxis machine tool (2) according to Claim 8 or 9, characterized in that a polynomial function serves as the freely selectable function.

11. Multiaxis machine tool (2) according to Claim 8 or 9, characterized in that a circular relation serves as the freely selectable relation.

12. Multiaxis machine tool (2) according to Claim 8 or 9, characterized in that a relation given by a table of values serves as the freely selectable relation.

13. Multiaxis machine tool (2) according to one of Claims 1 to 12, characterized in that the activation of the respective mechanical axis by the open-loop and/or closed-loop control device takes place by means of a freely selectable function or relation.

14. Multiaxis machine tool (2) according to one of Claims 8 to 13, characterized in that the activation of the respective mechanical axis by the open-loop and/or closed-loop control device takes place by means of a freely selectable function or relation which is dependent on the value of one of the virtual axes.

15. Multiaxis machine tool (2) according to Claim 14, characterized in that the activation of the respective mechanical axis by the open-loop and/or closed-loop control device takes place by means of a freely selectable function or relation which is also dependent on the value of further parameters.

16. Multiaxis machine tool (2) according to Claim 15, characterized in that a polynomial function which is dependent on the value of one of the virtual axes and polynomial coefficients serves as the freely selectable function.

17. Multiaxis machine tool (2) according to Claim 15, characterized in that a circular relation which is dependent on the value of one of the virtual axes and circle constants, preferably a circle radius and a centre point, given by a pair of coordinates,

and a direction of rotation serves as the freely selectable relation.

18. Multiaxis machine tool (2) according to one of Claims 8 to 17, characterized in that the activation of the respective mechanical axis by the open-loop and/or closed-loop control device takes place by means of a freely selectable relation which is given by a table of coordinates.

19. Multiaxis machine tool (2) according to Claim 18, characterized in that an X coordinate, a Y coordinate and a normal angle, preferably as viewed in end-on section, are used as coordinates of the table of coordinates.

20. Multiaxis machine tool (2) according to one of Claims 1 to 19, characterized in that a memory is also provided, stored in which are machine control parameters which are accessed by the open-loop and/or closed-loop control device.

21. Multiaxis machine tool (2) according to one of Claims 1 to 20, characterized in that in the memory in which machine control parameters accessed by the open-loop and/or closed-loop control device are stored there is a data structure which allows the parameterization of the virtual axis as a guiding axis for other axes.

22. Multiaxis machine tool (2) according to Claim 21, characterized in that in the memory in which machine control parameters accessed by the open-loop and/or closed-loop control device are stored there is a data structure which also allows the parameterization of any mechanical axis as a guiding axis for other axes.

23. Multiaxis machine tool (2) according to one of Claims 1 to 22, characterized in that in the memory in which machine control parameters accessed by the open-loop and/or closed-loop control device are stored there is a data structure which is intended for receiving a definition of the function or relation for the formation of the virtual axis by the open-loop and/or closed-loop control device.

24. Multiaxis machine tool (2) according to one of Claims 1 to 23, characterized in that in the memory in which machine control parameters accessed by the open-loop and/or closed-loop control device are stored there is a data structure which is intended for receiving a definition of the function or relation for the activation of the respective mechanical axis by the open-loop and/or closed-loop control device.

25. Multiaxis machine tool (2) according to Claim 24, characterized in that at least one predefined type of function or relation is provided and the data structure has at least one data field for the identification of the predefined type of function or relation, used for the definition of a function or relation of the respective mechanical axis.

26. Multiaxis machine tool (2) according to Claim 25, characterized in that a polynomial function, preferably of the sixth degree, with polynomial coefficients as parameters is predefined as a type of function.

27. Multiaxis machine tool (2) according to Claim 24 or 25, characterized in that a circular relation with a circle radius and a centre point, given by a pair of coordinates, and a rotating direction as parameters is predefined as a type of relation.

28. Multiaxis machine tool (2) according to one of Claims 24 to 27, characterized in that a table of coordinates with coordinates as parameters is predefined as a type of relation.

29. Multiaxis machine tool (2) according to Claim 28, characterized in that an X coordinate, a Y coordinate and a normal angle, preferably as viewed in end-on section, are used in each case as coordinates.

30. Multiaxis machine tool (2) according to one of Claims 24 to 29, characterized in that in the memory in which machine control parameters accessed by the open-loop and/or closed-loop control device are stored there is a data structure which is intended for receiving an identification of the workpiece flank being machined by the activation of the respective mechanical axis by the open-loop and/or closed-loop control device, preferably an identification for a flank on the right or on the left.

31. Multiaxis machine tool (2) according to one of Claims 24 to 30, characterized in that in the memory in which machine control parameters accessed by the open-loop and/or closed-loop control device are stored there is a data structure which combines at least one group of machine control parameters corresponding to a partial region of the workpiece, as a segment under a common segment identification, preferably a segment number.

32. Multiaxis machine tool (2) according to Claim 31, characterized in that such a group of machine control parameters for which the same axis is parameterized as the guiding axis are always combined as a segment.

33. Method of activating a multiaxis machine tool (2) according to one of Claims 1 to 32,

a virtual axis initially being parameterized as a guiding axis for other axes,

and then, during the operation of the machine for machining the workpiece, the other axes merely being synchronized in their positioning with the aid of this virtual guiding axis.

34. Data carrier or electronic carrier signal (3) with machine control parameters for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that

on the data carrier or the electronic carrier signal there is at least one data structure which has a data field which allows the parameterization of the virtual axis as a guiding axis for other axes, and

the data carrier or the electronic carrier signal (3) activates the machine tool (2) during the reading-in or after the reading-in by means of this data structure on the basis of the method according to Claim 33.

35. Data carrier or electronic carrier signal (3) with machine control parameters according to Claim 34 for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that on the data carrier or the electronic carrier signal there is at least one data structure which also allows the parameterization of a mechanical axis as a guiding axis for other axes.

36. Data carrier or electronic carrier signal (3) with machine control parameters according to Claim 34 or 35 for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that on the data carrier or the electronic carrier signal there is at least one data structure which is intended for receiving a definition of a function or relation for the formation of the virtual axis by the open-loop and/or closed-loop control device.

37. Data carrier or electronic carrier signal (3) with machine control parameters according to one of Claims 34 to 36 for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that on the data carrier or the electronic carrier signal there is at least one data structure which is intended for receiving a definition of a function or relation for the activation of the respective mechanical axis by the open-loop and/or closed-loop control device.

38. Data carrier or electronic carrier signal (3) with machine control parameters according to Claim 37 for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that the data structure has at least one data field for the identification of at least one predefined type of function or relation, preferably a type of polynomial function, a type of circular relation or a type of table of coordinates, which is used for the definition of the function or relation of the respective mechanical axis.

39. Data carrier or electronic carrier signal (3) with machine control parameters according to one of Claims 36 to 38 for reading into a multiaxis machine tool (2) according to one of Claims 1 to

32, characterized in that on the data carrier or the electronic carrier signal there is at least one data structure which is intended for receiving an identification of the workpiece flank being machined by the activation of the respective mechanical axis by the open-loop and/or closed-loop control device, preferably an identification for a flank on the right or on the left.

40. Data carrier or electronic carrier signal (3) with machine control parameters according to one of Claims 34 to 39 for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that on the data carrier or the electronic carrier signal there is at least one data structure which combines at least one group of machine control parameters corresponding to a partial region of the workpiece, as a segment under a common segment identification, preferably a segment number.

41. Data carrier or electronic carrier signal (3) with machine control parameters according to Claim 40 for reading into a multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that such a group of machine control parameters for which the same axis is parameterized as the guiding axis are always combined as a segment.

42. Multiaxis machine tool (2) according to one of Claims 1 to 32, characterized in that it also has means for reading machine control parameters for the open-loop and/or closed-loop control device from a data carrier or electronic carrier signal (3) according to one of Claims 34 to 41 into the memory.

43. Method of generating machine control parameters for a multiaxis machine tool according to one of Claims 1 to 32 and 42, characterized in that

    at least one data carrier or an electronic carrier signal (3) with machine control parameters according to one of Claims 34 to 41 is generated.

44. Computer system (1) for generating machine control parameters for a multiaxis machine tool (2) according to one of Claims 1 to 32 and 42 with at least one data processing unit and at least one memory, characterized in that the data processing unit is set up in programming terms in such a way that it generates at least one data carrier or an electronic carrier signal (3) with machine control parameters according to one of Claims 34 to 41.

45. Computer program which has instructions which are set up for carrying out the method according to Claim 43.

46. Computer program product which has a computer-readable medium with computer program coding means, with which, after loading the computer program, a computer is made by the program to carry out the method according to Claim 43.

47. Computer program product which has a computer program on an electronic carrier signal, with which, after loading the computer program, a computer is made by the program to carry out the method according to Claim 43.

48. Neutral data computer control system for a multiaxis machine tool for producing workpieces having a helicoidal generated surface with

a computer system (1) for generating machine control parameters for a multiaxis machine tool (2) according to one of Claims 1 to 32 and 42 with

at least one data processing unit and at least one memory, the data processing unit being set up in programming terms in such a way that it generates at least one data carrier or an electronic carrier signal (3) with machine control parameters according to one of Claims 34 to 41, or

a computer program according to Claim 45, or

a computer program product according to Claim 46 or 47,

and at least one multiaxis machine tool (2) according to one of Claims 1 to 32 and 42.